OPTICAL FIBER RECEPTACLE ADAPTOR, OPTICAL FIBER COUPLING SYSTEM, AND METHOD FOR ASSEMBLING THE OPTICAL FIBER COUPLING SYSTEM

BACKGROUND

[0001] This invention relates to an optical fiber receptacle adaptor, and in particular to an optical fiber coupling system that includes the optical fiber receptacle adaptor.

[0002] An optical fiber transceiver generally comprises a Transmitter Optical Sub-Assembly (TOSA) and a Receiver Optical Sub-Assembly (ROSA). Both of these optical sub-assemblies are aligned with respective openings or ports in a common housing of the optical fiber transceiver, and mounted therein. Each optical sub-assembly includes an optical fiber receptacle and an opto-electronic portion, with one end of the optical fiber receptacle being attached to an optical port on the opto-electronic portion. The other free-end of the optical fiber receptacle has an opening for receiving an optical ferrule, which includes an optical fiber.

[0003] An optical fiber plug can be connected to either of the optical sub-assemblies in the transceiver by inserting the optical fiber plug, into the respective port in the housing of the optical fiber transceiver. When the optical fiber plug is inserted into a port, the optical ferrule in the optical fiber plug is received into the opening of the optical fiber receptacle, to be aligned therein. The optical fiber plug may be, for example an optical fiber plug in accordance with a Type SC Standard or a Type LC Standard connector; and the ports in the housing of the transceiver are dimensioned in accordance with a corresponding Type SC or Type LC port.

[0004] The optical fiber receptacle on an optical sub-assembly, is typically not concentrically aligned with the port in the housing of the transceiver. Such misalignment is often due to displacement of the optical fiber receptacle relative to the opto-electronic portion of the optical sub-assembly. Displacement tends to occur when the optical fiber receptacle is optically aligned and attached to the

opto-electronic portion, because optical alignment between the optical fiber receptacle and the opto-electronic portion does not typically coincide with mechanical alignment between the optical fiber receptacle and the opto-electronic portion. Consequently, when the optical sub-assembly is mounted in the housing of the optical transceiver, the optical fiber receptacle is not concentrically aligned with the port in the housing.

[0005] Another cause of misalignment is the tolerance of the thickness of the opto-electronic portion of the optical sub-assembly, and the amount of compression of thermal sheets that may be applied to the opto-electronic portion prior to mounting within the optical transceiver housing. To compensate for the misalignment and allow the optical ferrule in the optical fiber plug to enter the opening in the optical fiber receptacle, the port on the transceiver housing is generally made larger than the cross-sectional area tolerances of the optical fiber plug. Consequently, the inserted optical fiber plug is not properly supported within the enlarged port, and the optical fiber plug moves or wriggles about. This movement or wriggling of the optical fiber plug results in less than optimal alignment of the optical ferrule within the optical fiber receptacle. Consequently, such wriggling introduces relatively large insertion loss (also termed wriggles insertion loss). The large insertion loss also causes non-repeatable mating performance between the optical fiber plug and a port on the optical fiber transceiver.

[0006] In order for the optical fiber receptacle of an optical sub-assembly to be at least substantially concentric to the port on the transceiver housing, a complex assembly process is required to align and mount the optical sub-assembly within the transceiver housing. The complex assembly process results in lower throughput and lower production yields of optical fiber transceivers.

[0007] Hence, there is a need for optical sub-assemblies to be mounted in an optical transceiver, which reduces wriggles insertion loss, and which requires a relatively simple assembly process.

SUMMARY

[0008] According to an aspect of the invention, an optical fiber receptacle adaptor is provided. The optical fiber receptacle adaptor has a receptacle end and a port end. The receptacle end is secureable to an optical fiber receptacle and is adapted to receive a free end of the optical fiber receptacle. The port end is adapted to receive an optical ferrule, and for urging the optical ferrule into communication with the free end of the optical fiber receptacle.

[0009] According to another aspect of the invention, there is provided an optical fiber coupling system including an optical fiber receptacle having a free end and an optical fiber receptacle adaptor as described above.

[0010] According to another further aspect of the invention, there is provided a method for assembling the optical fiber coupling system. The method includes inserting an optical fiber receptacle into a receptacle opening at a receptacle end of an optical fiber receptacle adaptor, and securing the optical fiber receptacle to the receptacle end, thereby assembling the optical fiber coupling system.

Brief Description of Drawings

[0011] The invention will be better understood with reference to the drawings, in which:

Figure 1 is an isometric drawing of an optical sub-assembly and an optical fiber receptacle adaptor of an optical fiber coupling system, according to an embodiment of the invention;

Figure 2 is an exploded isometric drawing of the optical fiber coupling system in Figure 1, and a locking module for securing the optical fiber receptacle adaptor to the optical sub-assembly;

Figure 3 is an isometric drawing of the optical fiber coupling system in Figure 2, wherein the optical fiber receptacle adaptor is shown engaged to the locking module and secured to the optical sub-assembly;

Figure 4 is a top view of the optical fiber coupling system in Figure 3;

Figure 5 is a drawing of a formfitting locking mechanism by which the locking module engages the optical fiber receptacle adaptor;

Figure 6 is a drawing of another formfitting locking mechanism by which the locking module engages the optical fiber receptacle adaptor;

Figure 7 is an isometric drawing of an optical fiber receptacle adaptor and a locking module according to another embodiment of the invention, the optical fiber receptacle adaptor is engageable with the locking module using a snap mechanism;

Figure 8 is an isometric drawing of an optical fiber receptacle adaptor and a locking module according to another embodiment of the invention, the optical fiber receptacle adaptor is engageable with the locking module using a pair of clips; and

Figure 9 is an isometric drawing of the optical fiber coupling system of Figure 3 shown mounted within a housing to form an opto-electronic module.

DETAILED DESCRIPTION

[0012] The optical fiber coupling system according to an embodiment of the invention includes an optical transmitter or receiver sub-assembly and an optical fiber receptacle adaptor. The optical fiber coupling system refers to an assembly which includes either an optical transmitter sub-assembly or an optical receiver sub-assembly, and the receptacle adaptor.

[0013] With reference to Figure 1, an exploded view of the optical fiber coupling system 1 according to an embodiment of the invention is shown. The optical fiber coupling system 1 includes an optical sub-assembly 2 and an optical fiber receptacle adaptor 6. The optical sub-assembly 2 includes an opto-electronic portion 3 and an optical fiber receptacle 4. The optical fiber receptacle 4 includes an optical ferrule receiving portion 5 for receiving an optical ferrule (not shown), for example from an optical fiber plug (not shown) on an optical fiber patchcord (not shown). The optical ferrule receiving portion 5 may also be referred as the free end of the optical fiber receptacle adaptor 6. When the opto-electronic portion 3 is a transmitter opto-electronic portion, the opto-electronic

portion 3 generates an optical signal which is output through the optical fiber receptacle 4 to the optical ferrule (not shown), which would be located in the optical ferrule receiving portion 5 of the optical fiber receptacle 4.

[0014] The optical fiber receptacle adaptor 6 includes a receptacle end 7 having a receptacle opening (not shown) that receives the optical ferrule receiving portion 5 or free end of the optical fiber receptacle 4, when the optical sub-assembly 2 is assembled with the optical fiber receptacle adaptor 6. The receptacle adaptor 6 further includes a port end 8 opposite to the receptacle end 7. The port end 8 has an optical fiber port 9 which is an opening for receiving the plug of the optical fiber patchcord. When the plug of the optical fiber patchcord is received within the optical fiber port 9, the optical ferrule from the plug is received into the optical ferrule receiving portion 5 of the optical fiber receptacle 4.

[0015] The optical fiber receptacle 4 of the optical sub-assembly 2 normally comprises an optical ferrule (not shown) housed within the optical ferrule receiving portion 5. When the plug of the optical fiber patchcord is received into the optical fiber port 9, the optical ferrule of the plug is aligned in the optical ferrule receiving portion 5 with the optical ferrule (not shown) of the optical sub-assembly 2.

[0016] Each optical ferrule has a bore defined therein for receiving an end portion of an optical fiber. By aligning the ferrules of the optical fiber patchcord and the optical sub-assembly 2, the optical signal generated by the opto-electronic portion 3 can be transmitted from the optical fiber of the optical sub-assembly 2 to the optical fiber in the patchcord with low signal loss. The optical fiber plug is compliant to, but not limited to, a Type SC Standard and a Type LC Standard connector (referred as "SC connector" and "LC connector" respectively). Accordingly, the optical fiber port 9 of the receptacle adaptor 6 for receiving the optical fiber plug includes, but not limited to, a Type SC and a Type LC port, respectively.

[0017] The optical ferrule receiving portion 5 includes a ring 10 which surrounds a tubular section 11 of the optical ferrule receiving portion 5. The ring 10 of the optical ferrule receiving portion 5 has a flat cut-off portion 12. The

shape of the receptacle opening (not shown) at the receptacle end 7 is complementary to the shape of the ring 10 having the flat portion 12 and a further ring 15 adjacent the flattened ring 10, so that the optical ferrule receiving portion 5 when received into the receptacle opening at the receptacle end 7 is fixed in position relative to the receptacle adaptor 6. In particular, the optical ferrule receiving portion 5 can only be received in a fixed position and direction into the receptacle opening such that the optical ferrule receiving portion 5 is aligned at least substantially in a centre position of the receptacle adaptor 6.

[0018] In an embodiment where the optical fiber port 9 of the receptor adaptor 6 is a Type SC port, an optical fiber patchcord having a SC connector can be inserted therein. Since the optical ferrule receiving portion 5 of the optical sub-assembly 2 is at the centre position of the receptacle adaptor 6, the optical ferrule of the SC connector is aligned with the optical ferrule in the optical ferrule receiving portion 5 of the optical sub-assembly 2. In this manner, the movement of the plug within the receptacle adaptor 6 is restricted. In other words, the port end urges the optical ferrule (of the SC connector) into communication with the optical receiving portion 5. The transmission of an optical signal between the ferrules of both the plug and the optical ferrule receiving portion 5 is less prone to insertion loss caused by wriggles since the ferrules are held more firmly in place than the current state of the art. This advantageous feature also results in robust repeatable mating of the optical fiber plug (not shown) and the optical fiber port 9.

[0019] The receptacle adaptor 6 may be secured to the optical sub-assembly 2 using adhesive in one embodiment. More specifically, a layer of adhesive may be applied on the surface of the ring 10 of the optical ferrule receiving portion 5. In this way, the receptacle adaptor 6 is glued to the optical ferrule receiving portion 5 when the optical fiber receptacle 4 is extended into receptacle adaptor 6, thereby securing the receptacle adaptor 6 to the optical sub-assembly 2.

[0020] The receptacle adaptor 6 may also be secured to the optical sub-assembly using a locking module 20 as shown in Figures 2-4. The embodiment of the locking module 20 as shown in Figure 2 includes a first locking portion 21 and a second locking portion 22. The first locking portion 21 has two cylindrical

protrusions 23, and similarly, the second locking portion 22 has two cylindrical protrusions 24. The receptacle end 7 of the receptacle adaptor 6 has two corresponding cylindrical undercut slots 29. Each undercut slot 29 of the receptacle adaptor 6 receives one protrusion 23, 24 from each of the first locking portion 21 and the second locking portion 22. The undercut slot 29 and each protrusion 23, 24 of the first locking portion 21 and the second locking portion 22 form a formfitting locking mechanism. In other words, the protrusions 23, 24 of the first and second locking portions 21, 22 fit snugly in the undercut slots 29 so that the protrusions 23, 24 are firmly locked therein. The first locking portion 21 and the second locking portion 22 are thus said to be engaged with the receptacle adaptor 6 as shown in Figures 3 and 4.

[0021] The undercut slots 29 of the receptacle adaptor 6 and the protrusions 23,24 of the first and second locking portions 21,22 may be of other shapes instead of the cylindrical shape, as long as the first and second locking portions 21,22 and hence the locking module 20, are engageable to the receptacle adaptor 6. Furthermore, each locking portion 21,22 of the locking module 20 may include only one locking portion 23,24 engageable to the receptacle adaptor 6 for securing the receptacle adaptor 6 to the optical sub-assembly 2.

[0022] With reference to Figures 5 and 6, other examples of the undercut slot of the receptacle adaptor 6 and corresponding protrusion of the locking module 20 are shown. In Figure 5, an example of a trapezoidal protrusion 30 and a corresponding trapezoidal undercut slot 31 is shown. The trapezoidal protrusion 30 is engageable to the trapezoidal undercut slot 31 by forming a formfitting locking mechanism with the trapezoidal undercut slot 31. Similarly, an example of an inverted-T protrusion 32 and a corresponding inverted-T undercut slot 33 is shown in Figure 6. The inverted-T protrusion 32 is engageable to the inverted-T undercut slot 33 by forming a formfitting locking mechanism with the inverted-T undercut slot 33.

[0023] In the embodiment shown in Figure 2, the first locking portion 21 and the second locking portion 22 each includes an arch portion 25, 26. When the first and second locking portions 21,22 are engaged to the receptacle adaptor 6,

the arch portions 25,26 abut each other to define a through-hole between the first and second locking portions 21,22. The first locking portion 21 has a recessed surface 27 and the second locking portion 22 also has a matching recessed surface 28. When the first and second locking portions 21,22 are engaged to the receptacle adaptor 6, the two recessed surfaces 27,28 form a single combined recessed surface surrounding an opening of the through-hole.

[0024] The optical fiber receptacle 4 of the optical sub-assembly 2 has a collar portion 13 and a flange portion 14. The collar portion 13 is disposed between the opto-electronic portion 3 and the flange portion 14. The flange portion 14 is between the collar portion 13 and the optical ferrule receiving portion 5.

[0025] When the first and second locking portions 21,22 are engaged to the receptacle adaptor 6, the collar portion 13 extends through the through-hole of the locking module 20. In addition, the flange portion 14 abuts the single combined recessed surface surrounding the opening of the through-hole formed by the first and second locking portions 21,22. The position of the optical ferrule receiving portion 5 may not be concentric with the flange portion 14 and the collar portion 13. The non-concentric position of the optical ferrule receiving portion 5 with the flange portion 14 may occur when optically aligning the optical fiber receptacle 4 with the opto-electronic portion 3, as the optical alignment between them does not typically coincide with their mechanical alignment. Since the position of the optical ferrule receiving portion 5 and the locking module 20 is fixed relative to the receptacle adaptor 6, the diameter of the through-hole is larger than the diameter of the collar portion 13, and the area of the single combined recessed surface is larger than the area of the flange portion 14. This allows the flange portion 14 and the collar portion 13 to be off-centered with respect to the optical ferrule receiving portion 5. However, the diameter of the through-hole is smaller than the diameter of the flange portion 14 so that the combined recessed surface surrounding the opening of the through-hole formed by the first and second locking portions 21,22 abuts the flange portion 14 to urge and thus secure the optical sub-assembly 2 to the receptacle adaptor 6.

[0026] The assembled optical fiber coupling system 1 according to the invention is shown in Figure 3. The plan view of the assembled optical fiber coupling system 1 is shown in Figure 4.

[0027] The locking module 20 described in embodiments shown in Figures 2 to 6 uses a formfitting locking mechanism for engaging the locking module 20 to the receptacle adaptor 6, thereby securing the receptacle adaptor 6 to the optical sub-assembly 2. However the invention is not limited to using a formfitting locking mechanism for engaging the locking module 20 to the receptacle adaptor 6. Other forms of locking mechanisms are possible, including but not limited to a snap mechanism and a clip mechanism.

[0028] With reference to Figure 7, an optical fiber receptacle adaptor 40 which is engageable with a locking module 41 using a snap mechanism is shown. The receptacle adaptor 40 according to this embodiment of the invention has two resilient arms 42 extending out from two ends of the receptacle end 43 of the receptacle adaptor 40. Each free end of the arm 42 includes a snap-hook 44. The locking module 41 includes two corresponding slots 45 at the two sides of the locking module 41 for accommodating the respective two arms 42 of the receptacle adaptor 40. The locking module 41 further includes an arch portion 46 and a recessed surface 47. The recessed surface 47 faces the receptacle end 43 of the receptacle adaptor 40 when the locking module 41 is engaged with the receptacle adaptor 40.

[0029] To engage the locking module 41 to the receptacle adaptor 40, the arms 42 are guided along each corresponding slots 45 of the locking module 41. The locking module 41 is pushed towards the receptacle adaptor 40 until it is snap-locked to the receptacle adaptor 40 by the snap-hooks 44 of the arms 42. When engaged to the receptacle adaptor 40, the collar portion 13 of the optical fiber receptacle 4 extends through the arch portion 46 of the locking module 41. The flange portion 14 of the optical fiber receptacle 4 abuts the recessed surface 47 of the locking module 41.

[0030] With reference to Figure 8, an optical fiber receptacle adaptor 50 which is engageable with a locking module 51 using a pair of clips 52 is shown. In this

embodiment, the locking module 51 is engaged to the receptacle adaptor 50 using the pair of clips 52 that clamps the two portions to each other. The locking module 51 in this embodiment also comprises an arch portion (not shown) and a recessed surface 53 similar to those of the locking module 41 in Figure 7. When engaged to the receptacle adaptor 50, the collar portion 13 of the optical fiber receptacle 4 extends through the arch portion of the locking module 51, and the flange portion 14 of the optical fiber receptacle 4 abuts the recessed surface 53 of the locking module 51.

[0031] Although only a single-portioned locking module is used in the embodiments as shown in Figures 7 and 8, two or more locking portions may be used as the locking module, for example, in the embodiment shown in Figure 2.

[0032] As mentioned above, the optical fiber coupling system 1 is able to receive the plug of an optical fiber patchcord to connect it to the optical sub-assembly 2 with low insertion loss and robust repeatable mating. It is therefore advantageous to use the optical fiber coupling system 1 according to the invention in an opto-electronic module, in particular an optical transceiver module wherein optical fiber patchcords can be received and connected thereto.

[0033] Therefore, according to another aspect of the invention, an opto-electronic module comprising a module housing and the optical fiber coupling system 1 is provided. The optical fiber coupling system 1 is mounted within the module housing 60 as shown in Figure 9. The optical fiber coupling system 1 includes the optical sub-assembly 2 and the optical fiber receptacle adaptor 6 as already described in the earlier aspect of the invention.

[0034] The module housing 60 comprises a housing panel 61 having two openings 62. The optical fiber coupling system 1 is arranged within the module housing 60 with the optical fiber port 9 of the receptacle adaptor 6 facing one of the openings 62 of the panel 61. With this arrangement, the plug of an optical fiber patchcord can be inserted into the optical fiber port 9 of the receptacle adaptor 6 through the opening 62 of the housing panel 61.

[0035] The optical fiber coupling system 1 can be mounted into the module housing 60 by screwing the optical fiber coupling system 1 thereon. The optical

fiber coupling system 1 may even be mounted into the module housing 60 using a clip or snap mechanism. It is also possible to simply glue the optical fiber coupling system 1 to the housing module 60 using adhesive.

[0036] According to an embodiment of the invention, another optical fiber coupling system (not shown) may also be mounted alongside the optical fiber coupling system 1 within the module housing 60. For example, in an optical transceiver module, one of the optical fiber coupling system may include an optical transmitter sub-assembly and a receptacle adaptor, and the other optical fiber coupling system may include an optical receiver sub-assembly and a receptacle adaptor. Therefore, the optical transceiver module having connection ports with low insertion loss and robust repeatable mating is thus formed according to this embodiment of the invention.

[0037] Advantageously, the invention provides a simple assembly process for assembling the opto-electronic module, compared to the current state of the art. Previously, the optical ferrule receiving portion 5 in the opto-electronic module needs to be aligned with the opening 62 in the module housing 60, so that the opening of the optical ferrule receiving portion 5 is concentric to the opening 62 of the module housing 60. This precise alignment of the optical ferrule receiving portion 5 results in a very complicated assembly process and hence high yield loss during the manufacturing of the opto-electronic module.

[0038] The optical fiber coupling system 1 according to the invention is able to align the optical ferrule receiving portion 5 of the optical sub-assembly 2 with the receptacle adaptor 6 automatically, so that the opening of the optical fiber receiving portion 5 is always at the centre of the optical fiber port 9 of the receptacle adaptor 6 (i.e. concentric to the optical fiber port 9). Therefore, the complicated assembly process for aligning the optical ferrule receiving portion 5 to the module housing opening 62 is eliminated, resulting in cost reduction and higher yield compared to the current state of the art.

[0039] The optical fiber coupling system 1 can simply be mounted within the module housing 60 so that the plug of an optical fiber patchcord can be inserted through the opening 62 of the module housing 60 into the receptacle adaptor 6.